First Semester Examination
2017/2018 Academic Session

January 2018

EAG444 – Soil Stabilization and Ground Improvement
(Penstabilan Tanah dan Pembaikan Tanah)

Duration : 2 hours
(Masa : 2 jam)

Please check that this examination paper consists of EIGHT (8) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi LAPAN (8) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions : This paper contains **FIVE (5)** questions. Answer **FOUR (4)** questions.

*[**Arahan :** Kertas ini mengandungi **LIMA (5)** soalan. Jawab **EMPAT (4)** soalan.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

1. The profile of **Figure 1** shows a uniform design fill and also an additional uniform fill for preloading purpose placed over the compressible clay stratum. The water level is at ground surface, as shown. The compression curve coming from consolidation test in the lab test is given in **Figure 2**.

*Profil di **Rajah 1** menunjukkan suatu tambakan seragam dan juga tambakan tambahan seragam bagi tujuan pra-bebanan di atas suatu lapisan tanah liat boleh mampat. Paras air di permukaan tanah seperti diberi. Garis lengkung daripada ujian pengukuhan di makmal diberi di **Rajah 2**.*

(a) Determine the eventual ground settlement due to the uniform fill and due to the preloading. The fill and extra material are both having a unit weight of 20 kN/m^3.

Tentukan enapan akibat tambakan seragam dan akibat pra-bebanan. Tambakan dan tambakan tambahan kedua-duanya mempunyai berat unit 20 kN/m^3 .

[6 marks/*markah*]

(b) In order to eliminate the consolidation settlement due to the uniform fill in 6 months, it is now desirable to treat the site using pre-fabricated vertical drains (PVD) together with the given preloading. By assuming an equivalent PVD diameter of 10 cm, determine the required PVD spacing. The consolidation curve relevant to the problem is given in **Figure 3** while the radial coefficient of consolidation is the same as vertical coefficient of consolidation. Table 1 and Table 2 are respectively the vertical and radial time factors for the corresponding degrees of consolidation.

*Bagi menghindari enapan pengukuhan akibat tambakan seragam dalam tempoh 6 bulan, kawasan tapak ini akan dirawat menggunakan kaedah saliran tegak (PVD) bersama dengan pra-bebanan. Dengan menganggap garispusat PVD 10 cm, tentukan jarak antara PVD yang diperlukan. Lengkung pengukuhan yang berkaitan dengan soalan ini diberi di **Rajah 3**. Jadual 1 memberi nilai Faktor Masa bagi saliran tegak manakala Jadual 2 memberi nilai Faktor Masa bagi saliran radial, bagi darjah pengukuhan yang berkaitan.*

[13 marks/*markah*]

(c) How much extra material would be required instead of the given one in order to achieve the same settlement and same pre-loading period without using the PVD.

Tentukan tambakan tambahan yang diperlukan sekiranya enapan dan tempoh pra-pengukuhan yang sama hendak dicapai tanpa menggunakan PVD.

[6 marks/*markah*]

The following equations will probably be needed:

(Persamaan berikut mungkin ada gunanya):

$\frac{S_p}{H} = \frac{\Delta e}{1+e_0}$; $T_v = \frac{c_v\, t}{H_{dr}^2}$; $n = \frac{d_e}{2r_w}$; $T_r = \frac{c_{vr}\, t}{d_e^2}$; U_{vr} = 1-(1-U_r)(1-U_v); $\frac{S_p}{H} = \frac{C_c}{1+e_0}$ log $\frac{\sigma_0' + \Delta\sigma_p}{\sigma_0'}$

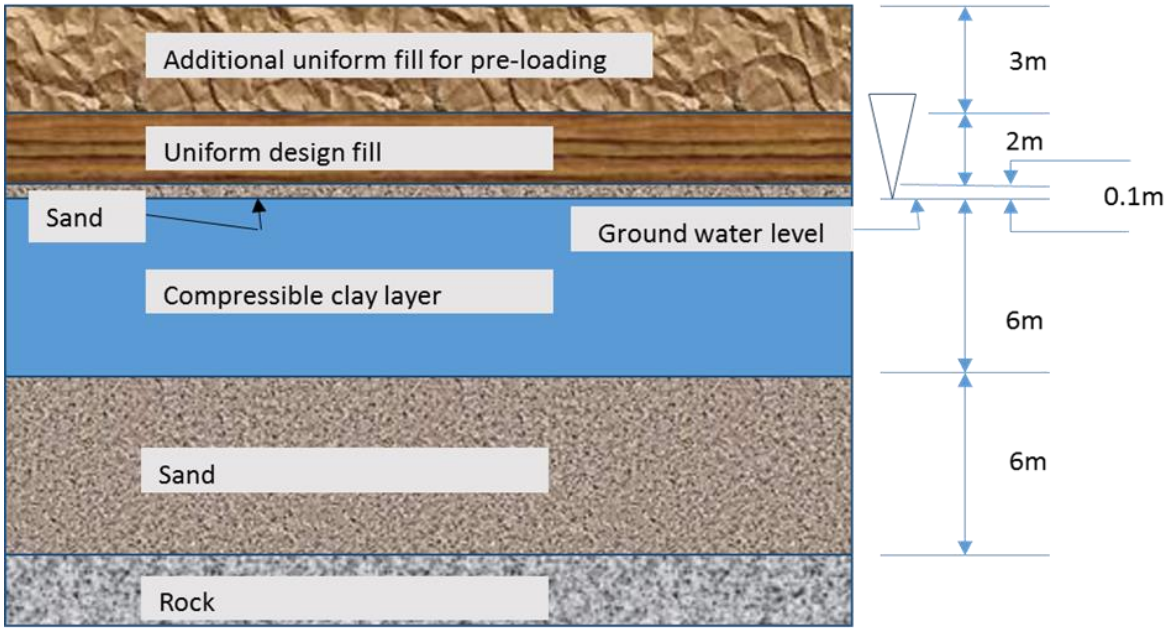


Figure 1 /*Rajah 1*

-A uniform design fill and also an additional uniform fill for preloading over compressible clay layer

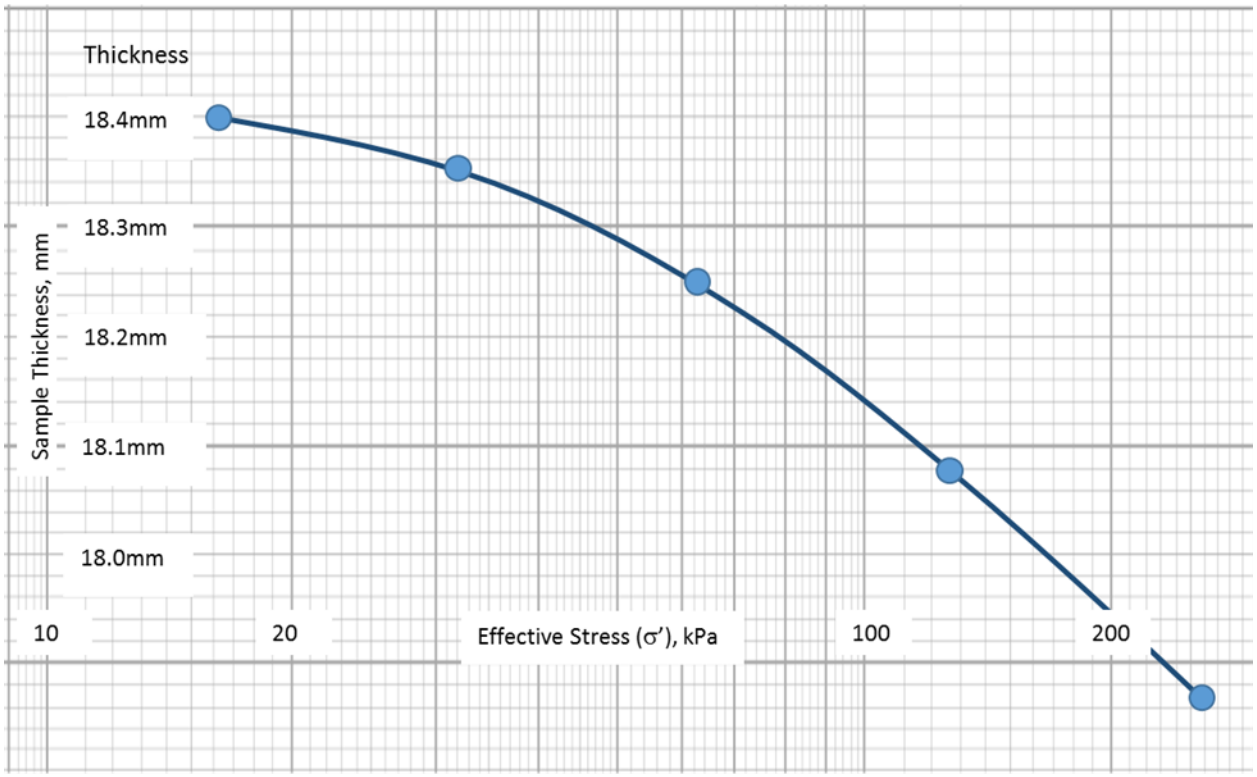


Figure 2/*Rajah 2*
The compression curve coming from consolidation test on clay sample

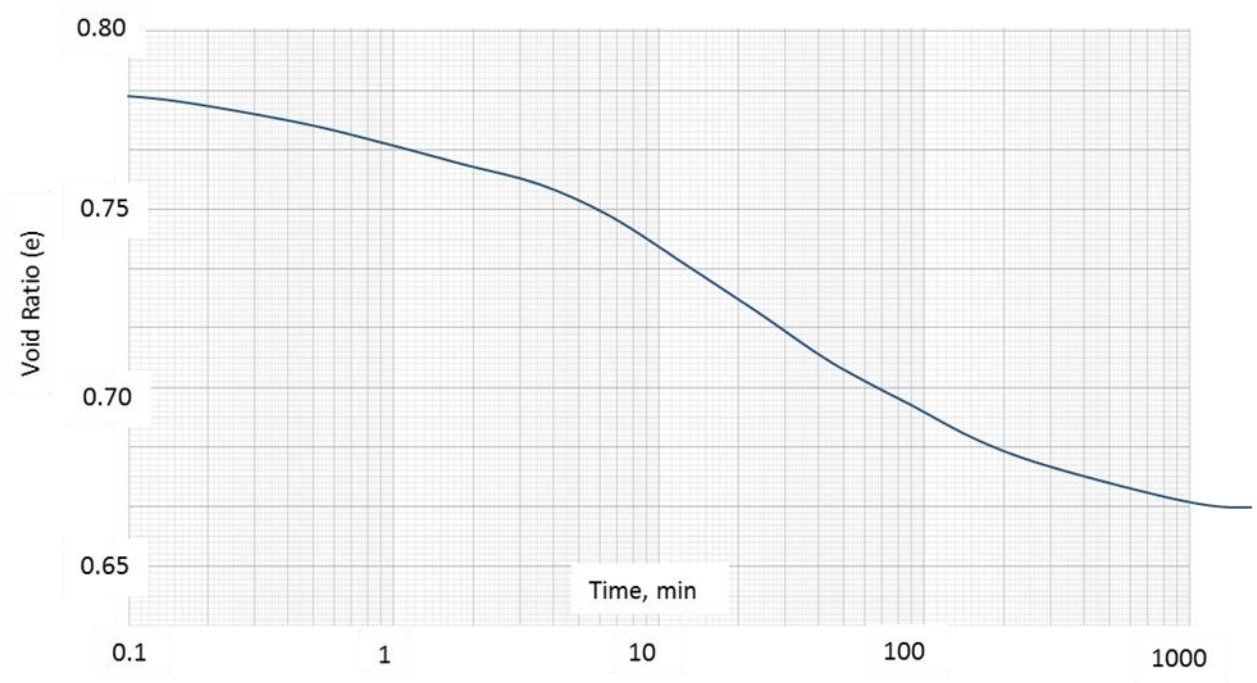
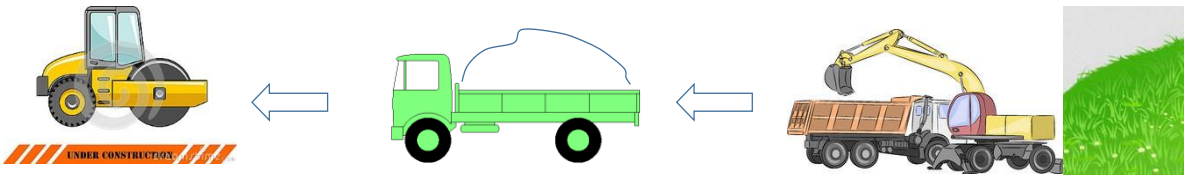


Figure 3/*Rajah 3*
The relevant consolidation curve for use in solving Question 1

2. **Figure 4** presents various values related to an 'excavation-transport-filling' work of a project. The relative compaction required of the fill is 95%. The maximum dry unit weight, γ_{dmax}, is 20 kN/m^3 and the minimum void ratio, e_{min}, is defined as the void ratio at the given maximum dry unit weight. The relative density, $\frac{e_{max}-e}{e_{max}-e_{min}}$, of soil while being transported is 22%. At the borrow site, the dry unit weight is 13 kN/m^3. The maximum void ratio of the soil is 3.0, while G_s is 2.6.

Rajah 4 *menunjukkan nilai-nilai yang terlibat dengan suatu kerja 'korek-angkut-isi' suatu projek. Mampatan relatif tapak adalah 95%. Berat unit maksimum,* γ_{dmax}*, 20 kN/m^3 manakala nisbah lompang minimum,* e_{min}*, telah dimaksudkan sebagai nisbah lompang pada berat unit kering maksimum. Nilai ketumpatan relatif,* $\frac{e_{max}-e}{e_{max}-e_{min}}$*, bagi tanah sewaktu diangkut 22%. Ditempat korekan, berat unit kering 13 kN/m^3. Nisbah lompang maksimum 3.0, manakala* G_s *2.6.*



At fill site:

γ_d=0.95$\gamma_{d(max)}$=19 kN/m^3

Volume=?

e =?

During transport:

$\frac{e_{max}-e}{e_{max}-e_{min}}$ = 22%

Volume=?

w= 20%

Weight=?

e =?

At borrow site:
Volume=3,000,000 m^3
γ_d=13kN/m^3

e_{max} = 3.0
$\gamma_{d(max)}$=20 kN/m^3

e =?

Figure 4/*Rajah 4*

(a) If the available borrow volume is 3,000,000 m^3, determine the resulting compacted volume at fill site if all of the borrow soil is used.

Jika isi padu korekan adalah 3,000,000 m^3, tentukan isi padu terpadat di tapak pengisian jika keseluruhan tanah korekan digunakan.

[13 marks/*markah*]

(b) Determine the void ratios of soil material at borrow site, while being transported, and when compacted at the fill site.

Tentukan nisbah lompang bagi tanah di tapak pengorekan, sewaktu diangkut, dan apabila sudah dipadatkan di tempat pengisian.

[6 marks/*markah*]

(c) Determine the total volume of soil material while being transported and its total weight if the moisture content is 20%.

Tentukan jumlah isi padu tanah sewaktu diangkut dan berat keseluruhannya jika kandungan airnya adalah 20%.

[6 marks/*markah*]

3. (a) Provide **FIVE (5)** names of geosynthetics describing the various applications when each is used in the construction industry.

*Namakan **LIMA (5)** jenis geosintetik merujuk pada pelbagai aplikasi dalam industri pembinaan.*

[5 marks/*markah*]

(b) Sketch each of the above **FIVE (5)** applications and define the role and function of the geosynthetics being used

*Lakarkan setiap satu daripada **LIMA (5)** aplikasi di atas dan terangkan peranan dan fungsi bagi penggunaan geosintetik tersebut.*

[14 marks/*markah*]

(c) What are the main important criteria in designing in any one of the above applications and relate the selected geosynthetic to its function.

Apakah kriteria utama yang penting bila anda merekabentuk menggunakan geosintetik dalam mana-mana salah satu aplikasi di atas dan kaitkan dengan fungsinya.

[6 marks/*markah*]

4. (a) What kind of soil movements that occur in the field related to slope instability and skektch **THREE (3)** types of movement.

*Apakah jenis pergerakan tanah yang terjadi dalam ketidakstbilan cerun dan lakarkan **TIGA (3)** jenis pergerakan.*

[7 marks/*markah*]

(b) Elaborate further **THREE (3)** issues of Question (a) in relation to causes of landslide.

*Terangkan dengan lebih lanjut tentang **TIGA (3)** isu utama penyebab Tanah runtuh seperti dinyatakan di soalan (a).*

[7 marks/*markah*]

(c) Describe the main important factors consider in improving a ground by:

Apakah faktor utama dalam penambahbaikan tanah bagi:

(i) increasing the shear strength.

meningkatkan kekuatan ricihan.

(ii) classifying the various modes of failure in landslides, and thus proposing the solution.

pengelasan untuk pelbagai mod tanah runtuh, dan cadangan pembaikan.

[11 marks/*markah*]

5. A 15 meter retaining wall required to be designed for one proposed highway project. Due to the lack availability of acquired land, a mechanically stabilized earth is proposed as shown in **Figure 5**. A sand back fill with unit weight of 15 kN/m^3 and friction angle of 30° will be used for the backfilling. The 5 mm thick and 75 mm width of ties-back strip will be used for the reinforcement. The allowable tension and interfacial angle of friction of the strip are 2.4 x10^5 kN/m^2 and 10° respectively.

*Dinding penahan 15 meter perlu direkabentuk untuk satu projek lebuhraya yang dicadangkan. Disebabkan kekurangan tanah yang diperolehi, tanah terstabil mekanikal dicadangkan seperti yang ditunjukkan dalam **Rajah 5**. Pasir kambus balik dengan berat unit 15 kN/m^3 dan sudut geseran 30° akan digunakan untuk kambus balik. Jalur pengikat 5 mm tebal dan 75 mm lebar akan digunakan sebagai tetulang. Ketegangan yang dibenarkan dan sudut antara muka adalah masing-masing 2.4 x10^5 kN/m^2 dan 10°.*

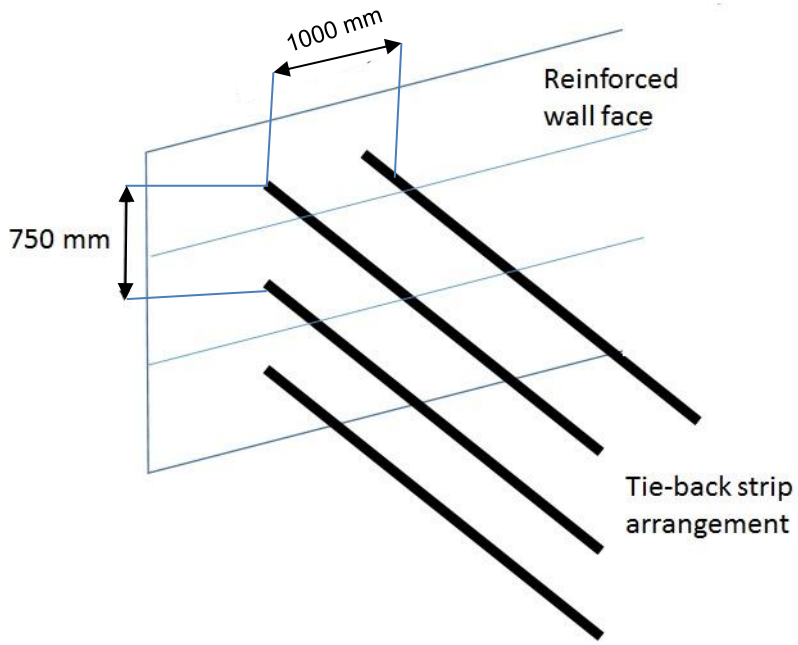


Figure 5 / ***Rajah 5***

(a) If the required factor of safety against tie breakage for the mechanically stabilized earth is 2.0, check if using this tie-back strip would be adequate.

Sekiranya faktor keselamatan disebabkan jalur putus yang diperlukan bagi penstabilan tanah secara mekanikal adalah 2.0, semak sekiranya dengan menggunakan jalur ikat belakang ini mencukupi.

[15 marks/*markah*]

(b) Discuss **TWO (2**) failure mechanisms of mechanically stabilized earth with the help of sketches.

*Bincangkan **DUA (2)** mekanisma kegagalan bagi penstabilan tanah secara mekanikal dengan berbantukan lakaran.*

[10 marks/*markah*]

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